United States
Department of
Agriculture

Forest Service

Fire Management Notes

Volumes 53-54, No.3
1992-93

Fire Management Notes

An international quarterly periodical devoted to forest fire management

United States Department of Agriculture

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Contents

Short Features

Front Cover: *"Light-hand-on-the-land" fire suppression tactics avoid unnecessary impacts on natural resources, as described in Francis Mohr's article. A few of the tactics shown are fire spread being extinguished by helibucket drops in place of cutting trees down with chain saws; in areas far from live streams, portable water-holding tanks with pumps and hoses are used for firelining; a Flame-N-Go Interagency Hotshot Crew member using a water fireline rather than a fireline that had been dug because it leaves fewer after-effects on the land; the fragmented and blasted face of an originally smooth-cut stump leaves a site more natural so it blends in with the natural appearance of the surroundings (see article, page 3). Photo credits: All photos by Francis Mohr, Wallowa-Whitman National Forest.*

Fire Management Notes is published by the Forest Service of the U.S. Department of Agriculture, Washington, DC. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department.

Subscriptions may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Send suggestions and articles to the Chief, Forest Service (Attn: *Fire Management Notes*), P.O. Box 96090, U.S. Department of Agriculture, Washington, DC 20090-6090.

Wildfire Suppressed—and the Wilderness Still Looks Natural!

Francis Mohr

Wilderness fire planning specialist, USDA Forest Service, Wallowa-Whitman National Forest, Baker City, OR

When we suppress a wildfire in wilderness areas, is it possible to leave few, if any, scars? Historically, aggressive suppression activities were used to control wildland fires, and many of these activities produced major visual imprints on the land. But in recent years, some managers have been attempting to use "light-hand-on-the-land" suppression tactics to avoid unnecessary adverse impacts on natural resources (Mohr 1989).

I had the opportunity to witness the light-hand approach during the 1,790-acre (724 ha) Kitchen Creek Wildfire on Idaho's Salmon National Forest, North Fork Ranger District, from August 14 to 20, 1991. Reflecting back, I can remember some major events that made light-hand suppression tactics possible—and the concept worked.

Directions From the Land Manager

"You have a fire order to work as my resource advisor with the incident team and field crews to implement light-hand-on-the-land suppression tactics on our wildfire," District Ranger Roger Thomas said to me on the morning of the first day of the fire. There was no doubt in my mind (nor anyone else's) about this land manager's fire suppression direction.

"You've been directed to contain this wildfire using a light-hand-on-the-land approach," was the statement in District Ranger Thomas's "Delegation of Authority" to Roy Johnson, the Incident Commander, and his national incident team. Incident Commander Johnson, from the Bureau of Land Management at the Boise Interagency Fire Center, Boise, ID, reiterated this message periodically that evening as members of his national team arrived from their home bases throughout the Intermountain West.

We can care for the land and protect resource values if, from the outset, we have strong management direction, commitment from the incident team, ongoing monitoring and clarification, onsite instructions, and feedback from managers.

Commitment

From the beginning to the end of this wildfire, it was clear Incident Commander Johnson's national incident team was determined to meet this relatively new management direction. As I remember them, events occurred in the following way:

North Fork Ranger District certified blaster Don Smith makes a hole in the top of a stump (from a tree cut during helispot construction) to install explosives. Using explosives on cut faces of stumps and boles is a technique to make them look natural. Photo credits: All photos in this article are by Francis Mohr, Wallowa-Whitman National Forest.

First Decisions. Within the first hour of their arrival, Merrill Saleen from the Payette National Forest and Dave Schen from the State of Utah Forestry Department (the operations chiefs), Joe Bistryski from Ashley National Forest (the air operations manager), and I discussed specific suppression tactics to contain the fire's perimeter and ensure its control. We also discussed the impact of helicopter use, because the firefighting crews would have to be flown into the remote location of the fire. We decided the actions we took must have minimal or no adverse impact on this wilderness resource.

Outline of Tactics. We developed and reviewed an outline of appropriate suppression tactics with various fuel situations. Then it was approved by Tom Zimmerman, planning section chief from the Denver office of the National Park Service. The outline was included in each daily Incident Action Plan. Since we anticipated that fire crews would have to sleep in a "spike camp" (temporary overnight site) along the perimeter of the fire, we also inserted a list of "no-trace" camping techniques and conduct in the Incident Action Plan. Both the appropriate suppression outline and spike camp tactics list appeared in every daily Incident Action Plan until the team left the fire.

Final Word to Departing Crew. Before the departure of the crews to the wildfire area, the four division group superintendents—Dave

Baumgartner, Wasatch-Cache National Forest; Dave Bull, Caribou National Forest; Tony DeFalco, Las Vegas office of the Bureau of Land Management, and Gary Elliot, Payette National Forest—stressed that the crews were to use the specific tactics listed in the outline. Eight interagency hotshot crews worked to suppress the wildfire: Alpine, Sawtooth, Black Mountain, Silver State, Flame-N-Go's, Logan, Prineville, and Zig Zag.

Selecting Helicopter Landing Sites. Before he selected locations for helicopters to land crew members, the air operations manager held an in-the-air review of proposed sites. Together, District Ranger Thomas, the helitack foreman, and I (as the resource advisor) discussed helispot construction impacts, safety, and probable restoration measures. This concern was another indication of the team's commitment to District Ranger Thomas's fire suppression direction.

Site Restoration. After the wildfire had been suppressed, Incident Commander Johnson, Deputy Incident Commander Ron Sanden from the Fishlake National Forest, and both operations chiefs visited the constructed helispots to observe the restoration efforts and discuss the best methods to make the site "blend in" with the natural, surrounding landscape. Sanden remained to test various rehabilitation techniques until he was certain the site would be satisfactorily restored to as natural a condition as possible.

Monitoring and Feedback

Aside from involvement with the team, my role was to observe how the ground crews implemented the light-hand fire suppression tactics. I was impressed that even though some had doubts about this approach and were uncertain that the tactics would work, they still were determined to meet the challenge of extinguishing the fire with light-hand techniques. It was a positive and rewarding experience to listen to their discussions of the approach that would leave little evidence of their having ever been in the area. Subsequently, I was the witness to their success.

Explosives are secured around the stump and bolewood of a cut tree to moderate the unnatural appearing impact on the land caused by helispot construction during suppression of the Kitchen Creek Wildfire.

Onsite and Aerial Monitoring. When the fire was about 75 percent contained, District Ranger Thomas conducted both onsite and aerial monitoring of techniques being used by the ground crews. That evening during the strategy planning and briefing meeting, Thomas commended the eight crews for their efforts but also expressed his concern about the long-term adverse impacts that some helispot construction had caused.

Mitigating Measures. District Ranger Thomas, both operations chiefs, the air operations manager, and I discussed mitigating measures for environmental and resource impacts caused by the helispots. We developed a list of rehabilitation techniques and included them in the Incident Action

A member of the Zig Zag Interagency Hotshot Crew flush-cuts one of several stumps that resulted during helispot construction.

Explosives used on the smooth cut faces of stumps and bolewood help them blend in with the surrounding untouched landscape. A landscape with broken bolewood fragments more closely resembles one with naturally fallen trees or trees blown over by the wind.

Plan. The next day, crew members rehabilitated helispots that were no longer important in the suppression activity.

Evaluation and Recognition

A week after the Kitchen Creek Wildfire began, I left the area of the incident to return to my official station in Baker City, OR. As I flew over the Frank Church—River of No Return Wilderness, I reflected back on what I had observed. I had a positive feeling about the entire week—what I had observed, the land manager's direction, the determination of the team and crew members to get the job done correctly. I was more convinced than ever that we had the skills, technology, and ability to suppress future wildfires without leaving a heavy-handed imprint of our actions on the land. Yet, I could remember past frustrations and long-lasting adverse impact from previous wildfire situations all too well.

It had not been long before this wildfire that I had seen the phrase "light hand on the land" as a written objective in some Incident Action Plans for other wildfires. But in those cases, implementation had not happened. It was quite clear that when the fire was over and the land managers were visiting the wildfire sites they were displeased a light-hand approach had not been used. Yet they voiced their disapproval when it was too late. Why weren't they more vocal at the beginning or while the fire was being suppressed?

In another situation, I had been confronted by a few who expressed concern that the light-hand-on-the-land concept was advocating nonaggressive fire suppression. It would "tie the hands of the firefighters from doing what they know best," or "jeopardize safety." And of course, I also heard from a few who labeled the concept as ridiculous and impractical in reality.

Recalling those cases made me wonder if our fire training had so strongly overemphasized fire as "an enemy" that we were immune to the long-lasting adverse impacts or resource damage caused during some fire suppression activities. Were we so engrained with controlling the "fire against time" instead of "managing it with time" that we had completely overlooked our agency's motto of "caring for the land"? Suppression of a wildfire does not give us license to overlook this basic goal of land ethics and prudent land stewardship.

Unburned, partially decomposed stump fragments were placed over the cut face of some bolewood to moderate the after-effects of helispot construction and make the surrounding landscape look natural.

"No Trace" Spike Camp Techniques and Conduct

- Select impact-resistant sites
- Avoid cutting vegetation or tree boughs for bedding and camping sites
- Avoid any trenching for bedding sites
- Avoid constructing too many campfire sites
- Limit travel routes to and from camp
- When leaving campsite: Restore area to as "natural" a condition as possible; scatter charcoal from campfire and rocks used for the fire ring; cover campfire site with soil and blend in with natural surroundings; and pick up all garbage and noncombustible materials, such as aluminum foil, and carry this material from the site

Then I thought back on the past few days and the scenes I had recently witnessed. We had suppressed a wildfire, and we had cared for the land and protected resource values. In particular, I remembered the innovative measures that one crew had used to mitigate existing conditions at one

How To Rehabilitate Constructed Helispots

The Impact. Helispot construction in wilderness areas can cause a double impact:

- Abrupt or unnatural appearing openings in a timber- and vegetation-covered landscape
- Cut faces of tree boles and stumps

Restoration Suggestions. Before starting restoration, walk through an adjacent, untouched area and observe the appearance, arrangement, and color scheme of a naturally evolved forest. Notice the variety and diversity of the natural landscape. Use what you have observed from the natural landscape to guide restoration efforts. Here are some things you can do:

- If bolewood can be moved, place the cut-end against or underneath existing downed material.
- For large bolewood that cannot be moved, place a slant cut (45° to 60° angle) on the bottom side.
- Cut stumps flush and camouflage them to blend in with the surrounding natural landscape. Scatter the sawdust and mix it with the natural surface debris.
- To camouflage cut faces of stumps and bolewood, use a variety of natural materials such as rocks, dead woody material, fragments of stumps, bolewood or limbs, soil, and fallen or broken green branches.
- As necessary, bring some natural material from adjacent, untouched areas to camouflage cut faces of stumps and boles. However, don't move excessive amounts of dead, downed woody debris; partially decomposed stumps and bolewood; or fragments of stumps and bolewood within or into the constructed helispot area. Excessive movement of such material could cause additional unnatural appearances.
- Do not lop and scatter tops of cut trees. (Lopping and scattering could create a harvest or precommercially thinned appearance instead of a natural landscape.)
- Selectively place a few of the cut saplings in an upright position, wedging them between downed logs, old root wads, and the like to recreate a natural appearing area with a few dead, standing trees rather than leaving a pile of slash.
- If there has been an excessive amount of bucking, limbing, and topping, consider slinging cut material from the helispot.
- Consider using explosives on some stumps and the cut face of bolewood (the end-result will resemble a wind-fallen tree).

For the 12-page, pocket-sized field guide, "Light Hand Tactics," that covers land manager, incident team, and firefighter considerations as well as implementation guidelines, contact Francis Mohr at (503) 523-6391 or P.O. Box 907, Baker City, OR 97814.

of the helispot areas. I had sensed their pride when, at the end, the site appeared to blend in with the surrounding natural landscape.

Yes, it had worked! We had proven that it was possible to suppress a wildfire while caring for the land and protecting resource values. But it was also obvious some major events had occurred that made it possible. From the outset, we had strong management direction, commitment from the incident team, ongoing monitoring and clarification, onsite instructions, and feedback from managers. Without these, the Kitchen Creek Wildfire would have been just another unacceptable memorial to inappropriate, poorly planned suppression efforts.

Can we ensure that light-hand tactics will continue to be used correctly? The words of John Burns,

Cut seedlings and pole-sized saplings were randomly packed into the surrounding timbered area so the constructed helispot would more closely resemble a natural appearing landscape.

Salmon National Forest Supervisor, echoed in my mind. "You need to be missionaries for this cause," he had stated during the close-out review the day before. He was right—from the Incident Commander to the individual crew members—in the future we all have to work to spread the word and make certain that we not only accomplish the suppression task but also meet future challenges of professional stewardship and good land ethics. ■

Literature Cited

Mohr, Francis. 1989. Light-hand suppression tactics—a fire management challenge. Fire Management Notes. 50(1):21-23.

Using Firefighting Skills in the Somalian Relief Effort

Tom Frey

Disaster management specialist, USDA Forest Service, International Forestry, Washington, DC

Charlie McDonald, a hydrologist from the Angeles National Forest, watched as the U.S. Air Force C-130 lifted off the runway and turned north. McDonald is a Military Airborne Fire Fighting Systems (MAFFS) liaison officer, and during a busy fire season he can often be found working with the MAFFS units in southern California. MAFFS units are specially equipped military C-130's used to drop aerial retardant on forest fires. However, this time, as the C-130 lumbered aloft, McDonald was not on the ramp at an air tanker base in southern California. He was on a ramp in Mombasa, Kenya, and the C-130 was carrying beans, rice, wheat, vegetable oil, and medical supplies destined for remote dirt airstrips in Somalia where 1 1/2 million people had been at risk of starvation because of drought and civil war.

Several months before the December 1992 landing of the U.S. Marines in Mogadishu, Somalia's capital, McDonald and five other Forest Service employees and one Bureau of Land Management employee had been filling key management, logistics, and coordination roles in the U.S. Government's humanitarian relief efforts in Somalia, including trips into Somalia to assess the progress on the ground.

At the height of the airlift operation in Mombasa, McDonald and the others were assisting in the coordination of 14 U.S. military C-130's, 2 German Air Force Transalls, 2 Belgian C-130's, and 2 commercial C-130's.

The airlift was an impressive coordination effort, which was made even more difficult because of similar large transport aircraft flying to the same remote strips from other airports in Kenya and Djibouti.

Forest Service's International Forestry staff—possessing logistics, management, and coordination skills honed in firefighting—helped in the Somalian humanitarian relief effort.

International Forestry's Disaster Assistance Support Program

The Forest Service's participation in disaster relief efforts in Somalia and other countries is channeled through the Forest Service's International Forestry Disaster Assistance Support Program (DASP). Deputy Chief for International Forestry Jeff Sirmon stated that, "this is an example of how interagency cooperation and coordination can make the best use of resources from within the U.S. Government."

Established in 1985, DASP is designed to fulfill an agreement between USDA's Office of International Cooperation and Development (OICD) and the U.S. Agency for International Development's Office of Foreign Disaster Assistance (OFDA). On a day-to-day level, DASP maintains a close working relationship with OFDA and has been able to assist OFDA by tailoring Forest Service emergency coordination systems and the Incident Command System (ICS) to meet the challenges OFDA faces with international disasters.

The Development of the Disaster Assistance Response Team System

To meet OFDA's specific field response needs, DASP used the National Inter-Agency Incident Management System to develop the Disaster Assistance Response Team (DART) and completed the "Disaster Assistance Response Team Manual,"

A Forest Service employee visits a well site in Baidoa, Somalia, one of the towns hardest hit by the famine. Photo credit: Ron Libby, USDA Forest Service.

A C-130 full of relief supplies destined for starving Somalians is unloaded. Forest Service employees helped coordinate the relief airlift. Photo credit: Renee Bafalis, USAID.

which describes the purpose and structure of the five DART functions (management, administration, planning, logistics, and operations). The manual also contains DART position descriptions, qualifications, and duty checklists. OFDA now dispatches DARTs to disasters throughout the world—wherever an operational response is required. To assist the DART members in the field, DASP produced the "Guide To Field Operations," drawing heavily on the concept, format, style, and size of the National Wildfire Coordinating Group (NWCG) "Fireline Handbook."

DASP has also developed a disaster response procedures manual for OFDA's Operations Center in Washington. DASP's mission continues to refine these tools and systems, constantly drawing on materials developed by the fire community and land management agencies, to increase the efficiency of U.S. disaster relief efforts overseas.

Increasing Need for Disaster Response

With the end of the Cold War and the increasing New World "disorder," OFDA's workload and response to more and more suffering worldwide have quickly and significantly expanded. Commensurate with this expanding responsibility, OFDA has increased its requests for assistance from DASP. In addition to Somalia, DASP has provided Forest Service and Bureau of Land Management emergency management experts to OFDA efforts in Sierra Leone, Russia, Moldova, the former Yugoslavia, Northern Iraq, Indonesia, and Angola in the past 2 years.

DART Training and Orientation

To meet these expanding requests, DASP developed a 3-day DART training and orientation session for Forest Service employees who have skills in logistics, air operations, planning, coordination, and telecommunications and have a desire to assist in international humanitarian relief efforts. The training session, with funding support from International Forestry Deputy Chief's Office and OFDA, orients the participants to the organizations, systems, and challenges, which are a part of international disaster response efforts. The training stresses the ability to be flexible and maintain a strong team philosophy because the international disaster arena has many characteristics of the emergency management situation in the United States before wide acceptance of ICS. Presently many international organizations, countries, and individuals at the foreign disaster site have their own agenda and procedures and no common system for working together. Two training sessions have been held. The first was at the Forest Service's Northern California Service Center in Redding in January 1993 and the second session was held in Atlanta, GA, in June 1993. Over 60 participants attended the training.

What's Ahead

The Forest Service is now redefining its expanded role of assisting other countries in the global community. Recent legislation led to the creation of a Deputy Chief area for International Forestry. International Forestry will be reviewing ways that it can not only assist in disaster response through DASP, but also work more closely with natural-disaster-prone countries to develop natural resource programs that may prevent or mitigate disasters, and improve emergency response systems. DASP looks forward to its participation in seeking solutions to these challenging issues. ■

New Lease on Life for FEPP Through GSA

This 1,000-gallon aircraft refuling tanker was transferred to the New Mexico State Forestry Division, converted to a pumper, and placed with the Encino, New Mexico Fire Department. Photo credit: Louis Casaus, Bernalillo District of the New Mexico State Forestry Division, New Mexico Minerals and Natural Resources Department.

Excess pickups, refueling trucks, trailers, airpacks, tires, helmets, and tools —what do these items have in common? Each was transferred to various USDA Forest Service offices by the General Services Administration's (GSA) Personal Property Management Division. GSA area utilization officers, working with both the Defense Reutilization and Marketing Offices and USDA Forest Service representatives, facilitate the transfer of Federal excess personal property (FEPP) that can be used or converted for use in the USDA's cooperative fire management program.

FEPP—Is It Important to Rural America?

Millions of dollars of excess equipment are transferred each year to State forestry services around the country and benefit many rural areas that would otherwise do without needed equipment. John Reedy with the Arkansas Forestry Commission writes—

The Excess Property Program [FEPP program] is very important to rural areas of Arkansas. After this property is acquired by the Arkansas Forestry Commission, it is made available to rural communities on a 50-year, no-fee lease agreement. These rural communities then convert this equipment into firefighting apparatus. The communities are given a set amount of time to put this property into operation and must fight fire within a 5-mile radius of their fire station. When the equipment is worn out, it is then brought back to the Forestry Commission and is sold on a GSA sale.

The aerial firefighting truck was transferred to the New Mexico State Forestry Division and was placed with the Santa Fe, New Mexico Fire Department. Photo credit: Louis Casaus.

Customer Friendly

GSA is happy not only to help the USDA Forest Service and State Forestry Commissions obtain property, but also to play a role in the conservation of this Nation's natural resources. For more information about Federal excess personal property availability, contact the GSA Property Management Branch in your region. Telephone numbers and contact names can be found on pages 36-40 of the 1993 GSA Customer Assistance Guide. To request a copy of this guide, contact the Centralized Mailing List Service at (817) 334-5215 and ask for publication OSSC-0003.

Kris M. Russell, *property disposal specialist, General Services Administration, Federal Supply Service Bureau, Forth Worth, TX* ■

Prescribed Burns? Share Information With Fire Weather Forecasters and Involve Them in the Planning[1]

Christopher J. Cuoco

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An average of 350 fire weather Special Forecast Requests are prepared each year by the fire weather forecasters in the National Weather Service Forecast Office (WSFO) in Denver. Up to 650 of these spot forecasts may be prepared during a severe fire season. Spot forecasts are written for wildfires, hazardous materials incidents, alpine search and rescue missions, and prescribed fires. Prescribed fires are planned fires; therefore, the accuracy of spot forecasts for these fires can be improved when the fire weather forecaster is included in the long-term planning process of a burn project. This can be accomplished in several ways.

Six Months to One Month Before the Projected Burn Period

Early in the planning process, discuss the burn project with a weather forecaster. Provide him or her a copy of the approved burn plan—it's the most important piece of information you can share. This way, forecasters can acquaint themselves with the project name, legal description, topography, prescription conditions, and projected dates of accomplishment.

Within this time period, a fire manager can request 30-, 60-, and 90-day weather outlooks which compare forecast temperature and precipitation to climatology over large areas of the country. These outlooks are not very detailed, but they can be applied to the local climatology to provide rough inputs to fire behavior models.

In the Denver WSFO, burn plans are filed by the agency and field office submitting the plan.

Four Weeks to Two Weeks Before the Projected Burn Period

Call your fire weather forecaster during this time. Discuss the long-range weather forecast and fuel moisture trends. This will help narrow the target burn dates. Also at this point, it is important to discuss with your weatherperson **exactly** the type of forecasting support you will need. There are standard elements in every spot forecast, but additional information often proves valuable. Such additional information includes predicted temperature, humidity, wind, and cloud cover for certain hours of the day or for a planned ignition time. An extra level of detail in a spot forecast will often require more comprehensive fire weather observations from the burn site. Your forecaster will let you know what is necessary.

During this period in the Denver WSFO, your burn plan would be placed in a file for pending prescribed burns as informational reading for all fire weather forecasters.

Ten Days to Two Days Before the Projected Burn Day

Communication between the fire manager and the fire weather forecaster should increase during this phase. The forecaster will have a much better idea of the forecast weather conditions, and you will have a better handle on fuel conditions, which, in turn, will allow more definite preparatory actions to take place in both the weather service and land management offices.

It is also time to start sending observations from the burn site to the weather forecaster. Fire and land managers have found that the extra effort expended in taking weather observations before a prescribed burn can increase the accuracy of weather forecasts and improve the chances of accomplishing objectives. Detailed, site-specific observational data are of great value to a weather forecaster. Take weather observations at the same time each day so that trends of temperature, humidity, and winds for the burn site can be identified. These trends can be compared to data from permanent observing sites in the area. If observations are taken across the range of elevations of the burn site and from the varying aspects involved, there is a definite enhancement of both your ability and your forecaster's ability to adapt forecasts to the different elevations and aspects.

Observations should be taken at the most critical times of day:

- 0600-0800 for low temperature and humidity recovery data.

[1] I would like to express my thanks to the following individuals who read various drafts of this paper and offered technical and editorial advice: Mike Rieser, Craig, CO, U.S. Department of the Interior, Bureau of Land Management (BLM); Tom Zimmerman, U.S. Department of the Interior, National Park Service (NPS), Colorado State Office; Greg Zscheachner, BLM, Billings, MT; my wife, Michele; and Eric Thaler, Science and Operations Officer, National Weather Service Forecast Office, Denver, CO. In addition, I would like to acknowledge that information in the courses S-390, Intermediate Fire Behavior, and S-490, Fire Behavior Calculations, which are taken by many land management and weather service personnel, was helpful in developing this article.

- 1500-1700 for the period of highest temperature, lowest humidity, and strongest diurnal winds.
- Planned ignition time if requested.

Weather observations taken during other hours of the day can help complete the database and provide opportunities for important remarks. Some remarks about the following are welcomed by fire weather forecasters:

- The time the morning inversion broke, if it is detectable.
- When the winds shifted to upslope and upvalley.
- When cumulus clouds began developing and reached stage II or stage III.
- The time precipitation began, its character and intensity.
- The time of maximum temperature and minimum humidity.
- Wind gust speed and the peak wind gust noted that day, its direction, and time of occurrence.
- The percentage of sky covered by clouds.

The fire manager should relay all observations to the fire weather forecaster daily, and, at the same time, use this opportunity to obtain updated weather forecasts right up to the afternoon before the burn.

When these "preburn" observations start coming into Denver, we start a file specifically for your project. The file will include the observations you send, your burn plan, any notes taken, and outlook forecasts previously provided. The burn site is also indicated on a topographic map displayed in the fire weather office. These actions will ensure continuity on the project with all the fire weather forecasters in the office.

The most important thing you can do is share information with a weather forecaster. Discuss prescribed burn projects and provide the forecaster a copy of the approved plan.

The Afternoon Before Burn Day

Request a spot forecast for the burn day. Provide a comprehensive observation(s) from the burn site; include the high temperature and low humidity. The forecast you receive should help you make a go or no-go decision.

The Day of the Burn: the Special Forecast Request

The standard Special Forecast Request asks for a weather discussion and forecasts of sky condition, precipitation chances, high and low temperatures and relative humidities, winds at eye level or 20 feet (6 m) above the ground, and smoke dispersal. As already mentioned, there are no rules against going a step further and requesting more specific information. Anticipate the kinds of information you will need and request that information. For example, it may be easier to track how well the temperature and relative humidity forecasts are verifying by requesting forecasts of these parameters at 2- or 3-hour intervals beginning at ignition time and ending at sunset. You can request a forecast for the time of high temperature and low humidity or a forecast for the time or the temperature at which the surface inversion will break.

The weatherperson will be able to determine what can be accurately forecast and the kinds of information you will need to provide. Detailed forecasts are a challenge to make, but because of a forecaster's workload, may not always be possible. Your fire weather forecaster will let you know when you are asking too much, for example, when requests may be beyond the forecasting science or when a forecaster's workload will not allow the extra time needed to make a forecast containing more detail than normal.

When To Adapt a Forecast or Request an Updated Forecast

Because actual weather conditions often vary slightly from what was predicted, a fire manager can decide to adapt a forecast or request a new forecast. This is done by monitoring the stability, winds, temperature, and relative humidity through measurement and visual indicators.

Stability. Measuring the temperature at different elevations can provide a fair estimate (though not the most accurate) of local stability. These temperatures will be greatly influenced by the heated ground. If it is possible, the best way to determine the stability of the atmosphere over a burn site is by taking air temperature readings at different altitudes from an aircraft. The most usable visual indicators of stability are cloud development and smoke column characteristics. The fire manager and fire weather forecaster can determine the types of clouds expected in the vicinity of the burn as well as the behavior of the convective smoke

column. These two indicators should be closely monitored each burning period.

Conditions indicating a more unstable atmosphere than predicted would include cumulus clouds developing to stage II (towering cumulus) an hour or two sooner than expected or a smoke column that rises faster and to a greater altitude than expected. Remember that more cumulus development may also indicate a higher moisture content in the atmosphere. A more stable atmosphere than predicted is indicated by cumulus clouds developing later or to less vertical extent and by a smoke column that remains much closer to the ground, giving rise to a potential smoke management problem.

If temperature measurements or the stability indicators suggest the actual stability to be significantly different from the forecast, request a forecast update. If the actual stability is only slightly different from the forecast, a fire manager may need only to adjust the expected fire behavior.

Winds. Depending on the terrain and weather pattern, local winds can be either incredibly easy or quite difficult to predict. Accurate wind observations which depict the true character of the slope and valley breezes for a specific site are necessary to produce a good wind forecast. Such data can yield information about the timing of daily wind shifts, the strength of valley breezes at different elevations, and the influence of free air winds at the valley bottom, midslope, and ridgetop.

Many factors can influence the development of slope and valley breezes, and there are many questions to be asked when determining if differences in wind direction and speed are significant enough to warrant requesting an updated forecast. Localized cloud cover in the morning will delay heating and slow down the transition from downslope to upslope winds. Take a good look at the cloudiness at the site. Is there more or less coverage than expected? Is the cloud cover increasing or decreasing? How is the cloud cover affecting the temperature? Can the difference in cloud cover account for the difference between the forecast and actual temperature and, therefore, the difference between the forecast and actual wind?

If the shift to upslope/upvalley winds is delayed by more than an hour, or if the actual wind speed varies from forecast by 5 mph or more, it is best to request a new forecast. The fire manager can usually adjust the expected fire behavior for smaller differences in wind speed.

Wind direction is influenced by the same factors as wind speed. Always be suspicious of any wind direction that is different from what you would expect the terrain to produce. If you observe winds that run counter to the normal slope and valley breezes and these winds are not predicted, there may have been a drastic change in weather conditions. You should request a new forecast immediately.

Weather Support Planning Checklist

1. **Six months to one month before** projected burning window
   - ❑ send approved burn plan to fire weather meteorologist.
2. **Four weeks to two weeks before** burning window
   - ❑ call fire weather forecaster to discuss long-range forecast,
   - ❑ decide specific weather support to be requested, and
   - ❑ decide observational data necessary for such support.
3. **Ten days to two days before** burn day
   - ❑ start taking daily observations from the burn site (include pertinent remarks), and
   - ❑ provide observations to the fire weather forecaster.
4. **Afternoon before** the burn
   - ❑ request a Spot Forecast for the burn day, and
   - ❑ in addition to normal observation data, include high temperature and low humidity, and pertinent remarks.
5. **Each day** of the burn project
   - ❑ request forecasts and provide feedback to the forecaster.
6. **Post-project assessment**
   - ❑ make subjective assessment of overall weather support as related to accomplishing fire and land management objectives;
   - ❑ provide suggestions to fire weather forecaster about weather support for future projects.

Temperatures and Humidities. Adapting a temperature and humidity forecast is easy and is done often. A 20-percent difference in cloud cover may lead to a change of 1 to 3 degrees F in the high temperature, a slightly higher relative humidity, and a short delay in the shift to upslope and upvalley winds. Such small differences rarely throw the conditions out of prescription. A new high temperature and low humidity can be deduced, and fire behavior calculations can be adjusted. Usually, if the actual temperature differs from the forecast by 5 degrees or more, or the actual humidity differs from the forecast by 15 percent or more, it is best to request a new forecast.

Al Roberts of the USDA Forest Service, Rocky Mountain Regional Office (CO), provided an excellent method to track temperature and humidity and adapt the forecasted afternoon extremes. He suggests plotting the forecast temperatures and humidities for every 2 to 3 hours, then plotting the measured parameters on the same graph paper. When comparing the two trend lines, what becomes evident is the difference between the forecast temperature and humidity and the measured temperature and humidity. This information allows the fire manager to make a slight but important adjustment to the forecast of the high temperature and low humidity, yielding a more accurate depiction of the fire behavior conditions.

Feedback. Continue communicating with the fire weather forecaster during and after your project. Followup calls each day and after the project is completed are just as important as preburn planning. Always relay the weather observations taken during the burn and your daily assessment of the weather forecast. This information will help produce a better forecast for the next day of your project. Feedback after the project is completed should include sending a copy of your project evaluation to your fire weather office. Verbal feedback allows the fire manager to provide a subjective assessment of the overall weather support and to make suggestions about weather support for future projects.

Summary. There are many ways to improve weather support for prescribed burn projects. The key purpose of each recommendation is improving communications between the fire manager and the fire weather meteorologist. These recommendations are summarized in the weather support planning checklist. Obviously, all of the recommendations presented here cannot be applied to every project. By talking with your supporting meteorologist, you can discover which practices can be used routinely and which may be applied to individual situations. Improved planning for weather support should result in more accurate weather forecasts and more effective accomplishment of prescribed burning objectives. ■

Wooden Pride for 10 Years

What would you do if you found a defective bole section of a tree on the forest floor? When Michael D. Cain, research forester for the USDA Forest Service's Southern Forest Experiment Station in Monticello, AR, saw an 8-foot (2.4 m) by 26-inch (66 cm) diameter loblolly pin (*Pinus taeda* L.) bole, he saw an opportunity to rescue the abandoned log from the forest, much like Smokey's rescue from the aftermath of a forest fire. Using a chain saw and wood chisel, he carved the 7-foot (2.1 m) wooden replica of Smokey Bear over four weekends. The statue of the world-famous wildfire prevention symbol has been on display in the lobby of the Crossett Experimental Forest in southern Arkansas since 1983. This proud wooden Smokey reminds about 500 visitors annually of the importance of protecting wildlands from unwanted fire. Photo credit: Michael D. Cain, Southern Forest Experiment Station, Monticello, AR, USDA Forest Service. ■

Donna M. Paananen, *technical publications writer, USDA Forest Service, North Central Forest Experiment Station, East Lansing, MI*

The Weather Factor: Highlights From a Workshop on Fire, Weather, and Geographic Information Systems

Jennifer L. Rechel

Geographer, USDA Forest Service, Pacific Southwest Research Station, Riverside, CA

Wildland fire managers and planners rely heavily, when making decisions, on information that describes environmental factors. Chief among the environmental factors are weather events, which were the focus of an interdisciplinary workshop.

The more that is known about weather, the more successfully forest fires can be fought. Hence, a workshop focusing on the issues and interaction of fire, weather, and spatial analysis, cosponsored by USDA Forest Service's Pacific Southwest Research Station and the University of Arizona, was held February 26-28, 1992, in Tucson, AZ. The workshop brought together professionals in the fields of fire, weather, and spatial analysis from the USDA Forest Service, the U.S. Department of the Interior's National Park Service, and universities. The forum enabled the diverse group of professionals to investigate critical management and research needs for spatial analysis, the discipline of describing the location, size, and distance in which an object exists on the earth's surface or in the earth's atmosphere.

The workshop promoted personal interaction and technology transfer needed by wildlife fire managers and planners who rely heavily on information that describes environmental factors when making decisions. Chief among the environmental factors are weather events.

More Accurate Fire Behavior Predictions

Complex and dynamic interactions between weather and fire require integrated meteorological information that can be used to predict how severe a fire will be and how it will behave. Geographic Information Systems (GIS) improve predictions. GIS enables researchers and managers to model the interaction of weather, fire behavior, and fire effects information with factors such as fuel type, slope, and aspect. GIS is also the tool that allows in-depth spatial analysis to be done.

Fire behavior is the way in which a fire reacts to fuel and topography. Fire effects are the physical, biological, and ecological impacts of fire on the environment; examples are fire benefits and fire damage to vegetative areas. Aspect is the direction toward which a slope faces.

Topics of workshop sessions included weather forecasting and network design, fire and landscape ecology, fire growth and behavior, and fire and risk management. Aside from teaching the latest on these topics, workshop instructors identified some of the needs in each of these areas (itemized in the paragraphs that follow).

Needs for Weather Forecasting and Network Design

Professionals in the field need a more thorough understanding of existing technologies and would benefit from taking more advantage of current technologies, but some barriers hinder easy access to weather technology. For example, one Federal agency gathers weather information, while another deals with fighting and managing forest fires. Information exchanges are not always possible or easily arranged. Needs identified in this subject area were:

- Integrating weather analysis and prediction information into a unified fire management and planning decision process
- Sharing data collected by government agencies to eliminate redundancies
- Instituting quality control for collected data to make sharing among different departments easier and more worthwhile
- Integrating fire and weather data into coupled mesoscale (regional, several hours to several days) numerical models
- Incorporating high-resolution data on radar precipitation estimates and soil moisture for use with fuel moisture estimates.

Needs for Understanding Fire and Landscape Ecology

Some workshop sessions examined how landscape ecology fits into the firefighting picture and where research is headed. Needs identified in this area were:

- Developing spatial hypotheses on fire processes for testing on actual landscapes
- Representing dynamic fire and weather processes on space and time scales at the landscape level
- Clarifying scale definitions of fine, coarse, and transitional
- Aggregating and combining fire data collected at regional and local scales.

Needs for Predicting Fire Spread and Behavior

Ways to predict a fire's growth or behavior, and issues surrounding these subjects, were discussed. These sessions identified the following needs:

- Developing spatial hypotheses for research fire processes that are capable of being tested
- Collecting better observations of small-scale wind dynamics, wind-terrain interactions, and wind-fire interactions
- Defining, as agency policy matters, long- and short-term goals for various behavior modeling efforts
- Documenting current capabilities in the areas of fire science knowledge, fire behavior models, diagnostic wind models, and new technologies (for instance, Geographic Information Systems (GIS), Global Positioning Systems (GPS), object-oriented programming (OOP), and image segmentation).

Needs for Managing Fire as a Risk

Managing risk and making decisions on prescribed burning were also discussed. Sessions on this topic identified these needs:

- Deciding what kind of landscape vegetation is wanted and narrowing the difference between qualitative and quantitative GIS fire-weather models
- Identifying and making tradeoffs between risk assessment and risk management
- Using simulation models to find the most suitable sites for prescribed burning near urban developments
- Achieving balance between trying to find optimal solutions and making tradeoffs when managing fire risk
- Improving simulation models that project costs and consequences of fire risks.

Desert Field Trip

Thirty-five attendees participated in a field trip that studied fire effects on desert land. Led by George Long and Mac Kaplan (both of the Coronado National Forest), the group went into the outdoors to do some practical learning in the Santa Catalina Mountains of Arizona's Coronado National Forest. Field trip participants examined changes to desert plant communities resulting from fires from the 1960's through 1992. They broke up into small groups near the former fire sites and discussed pros and cons of the changes to habitat of bighorn sheep.

Workshop Outcomes

Participants came away from the workshop with increased awareness of GIS, broadened views on spatial analysis as a component of GIS, and benefits from exchanging information among a diverse group of professionals. In addition, workshop instructors outlined steps for participants to take to integrate fire and weather interactions, and to then model them.

The discussion groups outlined steps for continued research and management exchange, including:

- Putting in place a mechanism for integrating data from various Federal, State, and local agencies
- Providing an overview of current tools and capabilities of computer software and hardware
- Providing some common terminology.

Participants made an urgent request for an electronic bulletin board or a centralized pool from which information about fire, weather, and spatial data could be accessed easily.

The forum stressed the importance of conducting meteorological research that includes general weather observations and weather information used both to manage on-the-ground fires and to expand fire research. For example, meteorological research that meets these goals takes into account uncertainties in the data and then is used to develop numerical techniques to perform function-fitting atmospheric analyses.

Field trip participants left the workshop with some practical experience in fire effects in a desert ecosystem and got some variety learning in an outdoor setting. ■

Do-It-Yourself Class A Foam Eductor

David Hildebrand

Forest manager, Blue Rock State Forest, Ohio Department of Natural Resources, Blue Rock, OH

Need a low-cost way to introduce Class A foam into your wildland fire suppression activities? The foam eductor discussed here costs one-tenth of the price of a commercially manufactured model.

During the 1990 fire season, I began using an all-terrain vehicle (ATV) for Ohio's wildland fire suppression activities. This ATV proved very effective because it could be used in rough terrain and had a 35-gallon (132.5 l) water capacity. It was soon apparent, however, that the ATV could be even more effective with Class A foam.

At first, I tried pouring the foam concentrate directly into the water tank (batch mixing). This mixing proved not to be practical because there was too much foaming. Also, when I refilled the tank, the foam spilled out and caused a mess. I knew that a small, commercially available eductor—a device that combines water and concentrate outside the tank—was the solution to the problem. The eductors currently on the market can cost over $300 each, however, which is too expensive for our tight budget.

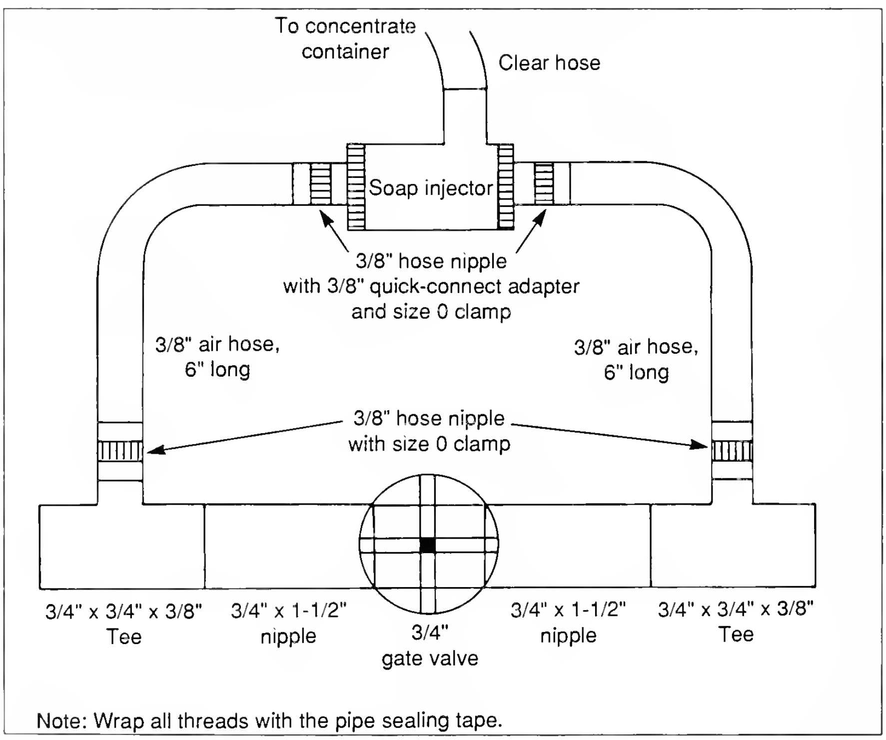
After several experiments, I built an eductor that works successfully for about one-tenth of the price of a commercial eductor. The diagram in figure 1 illustrates how its various components fit together. It can be adapted to any wildland engine.

The Injector

The heart of this eductor is the soap injector, which I purchased for $14.99

The all-terrain vehicle with a 35-gallon (132.5 l) water capacity—ready to fight wildfires with Class A foam. Photo credits: All photos in this article are by David Hildebrand, Blue Rock State Forest.

Figure 1—*Various components of the eductor and how they are assembled.*



in 1991 (see table 1). (This is the same part that allows you to switch from soap to rinse at a do-it-yourself carwash.) The injector requires a minimum waterflow of 2 gallons (7.6 l) per minute to deliver the concentrate into the system. In addition to being adjustable for concentrate flow, the injector has a built-in check valve to prevent water from flowing back into the concentrate container.

This injector operates on the principle of a pump pushing a large amount of water through a small hole. When it restricts waterflow, it creates the suction necessary to move the concentrate into the system. However, the small hole can easily become plugged, which would defeat the system except for the quick-disconnect feature. This feature, which is similar to any hydraulic system, ensures that an operator in the field can clear obstructions in the injector without using any tools.

Using the Eductor

After following the diagram in figure 1 to build an eductor (be certain to wrap all the threads with the pipe sealing tape), plumb it into the discharge (or downstream) side of the pump. Then follow these steps:

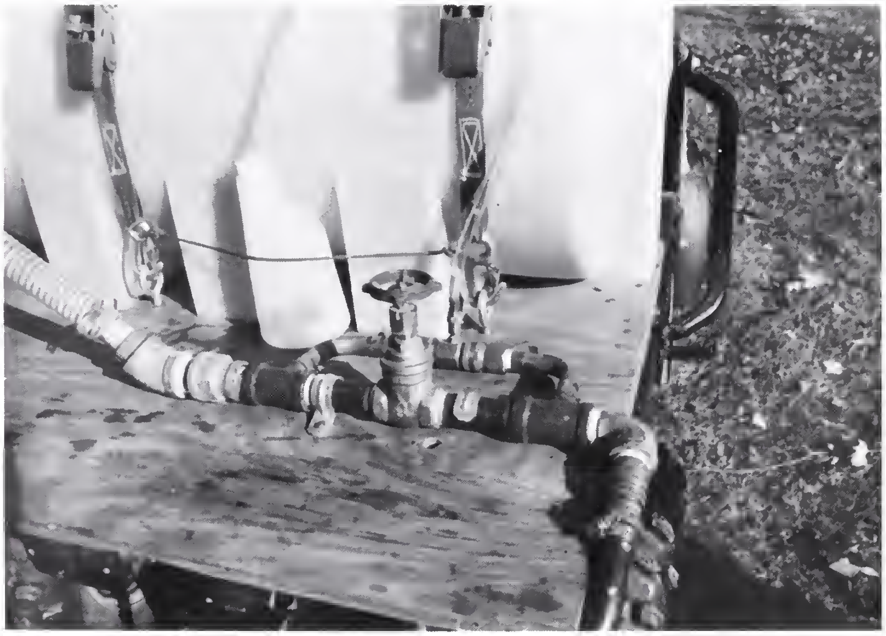
- Open the gate valve as wide as possible before starting the waterflow (to prevent sudden water pressure from damaging the injector).
- Notice the foam concentrate starting to move up the tubing as you begin to close the gate valve.
- Regulate the amount of concentrate entering the waterflow by opening

Table 1—*Parts list* to build an eductor for use in wildland fire control*

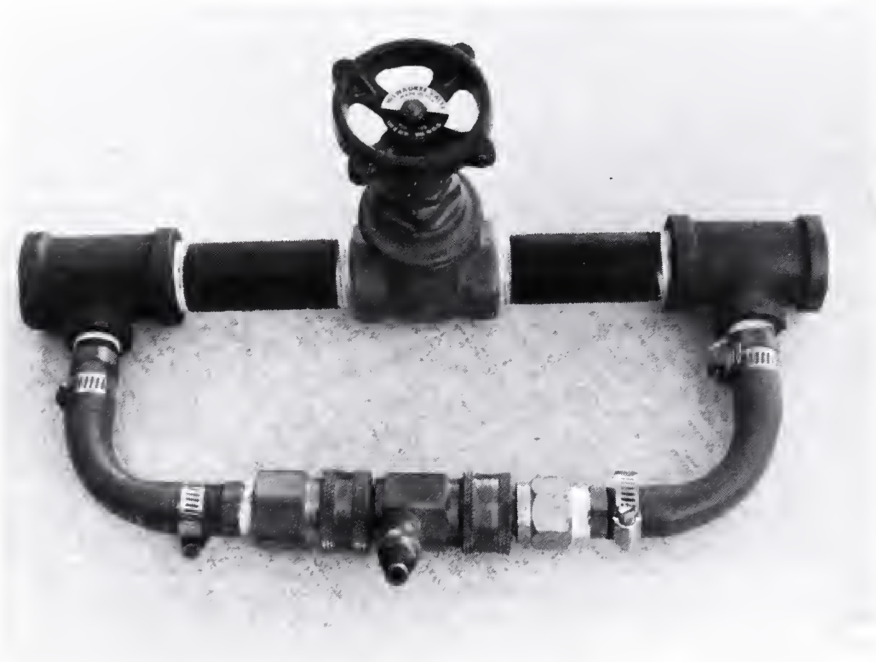
Quantity	Description	Unit cost ($)	Total cost ($)
2	3/4" x 3/4" x 3/8" (1.9 cm x 1.9 cm x .95 cm) TEE	1.99	3.98
2	3/4" x 1 1/2" (1.9 cm x 3.8 cm) nipple	.75	1.50
1	3/4" (1.9 cm) gate valve	8.38	8.38
4	3/8" (1 cm) hose nipple	.70	2.80
2	3/8" (1 cm) quick-connect adaptor	1.29	2.59
1	3/8" (1 cm) air hose, 12" (30.5 cm) long	1.00	1.00
1	5/16" (.8 cm) clear tubing, 36" (91.4 cm) long	.90	.90
4	Small (size 0) band clamps	.50	2.00
1	Roll of pipe sealing tape	.50	.50
1	2-gallons-per-minute (7.6 lpm) injector	14.99	14.99
	Total		**38.64**

**All parts except the soap injector can be purchased at most hardware stores. Prices may vary according to location. The soap injector (part number 2262) can be ordered from Northern Hydraulics 1, P.O. Box 1499, Burnsville, MN 55337-0499 or telephone 1-800-533-5545.*

1 The use of trade names does not constitute official endorsement of the product by the USDA Forest Service.



The eductor plumbed into the firefighting apparatus.



The eductor that costs one-tenth of the price of a commercial product.

Matt Winland, a Blue Rock State Forest firefighter, uses the eductor to apply Class A foam successfully.

or closing the gate valve a small amount.

- Determine the needed amount of concentrate by measuring the amount of water to be used.

Calculating Concentrate Needed

Because the tank on the ATV held 35 gallons (132.5 l) of water, I calculated I would need to use 22.4 ounces (662.5 ml) of foam concentrate per tankful to get the .5 percent solution recommended by the manufacturer of the concentrate. My calculations are as follows:

35 gal. x 128 oz. per gal. =
4,480 oz. x .005 = 22.4 oz.
(132.5 l x 1,000 ml per l =
132,500 l x .005 = 662.5 ml).

By using several tankfuls of water, I learned how to adjust the concentrate flow so that it matched the needed amount. I then made a small mark on the valve body to aid in returning to the setting. When the eductor is installed and the valve is fully open, it flows at a rate of 35 gallons (132.5 l) per minute. When it is set to flow concentrate at a rate of .5 percent, the eductor flows at 22 gallons (83.3 l) per minute—the most useful rate for agencies needing a low-flow Class A foam system.

Many fire agencies will find this eductor to be a cost-effective method to introduce foam into fire suppression activities. For further information, contact David Hildebrand, Division of Forestry, 6665 Cutler Lake Road, Blue Rock, OH 43720 or telephone (614) 674-4035. ■

Chain Saw Safety: The How-To's of Inspecting, Cleaning, and Repairing Chain Saw Chaps

A Triggering Event

In 1992, a chain saw operator was injured from a cut-through of the chaps. The injury required 20 stitches to the upper left outside quadrant of the left leg. An investigation of the accident indicated that improper cleaning (commercially laundered) and improper repair contributed to the severity of the injury.

How To Wear

- Adjust properly so chaps are snug (not tight or loose) to keep them positioned correctly.
- Wear chaps of the correct length, 2 inches (5 cm) below boot top.
- Avoid intentionally resting the bar and chain on the chaps. (Protective chain saw chaps are not to be used as a chain stop.)

How To Inspect

- Check the nylon shell for exhaust burns and surface cuts.
- Check for damage to the inner Kevlar layers.
- Remove from service and destroy if—
  - Either leg has more than five patches
  - More than two patches over three layers deep are on one leg
  - Any cut exceeds 7 inches (18 cm)
  - Material torn out cannot be smoothly put back into place
  - All layers have been cut through
  - Other damage that appears beyond safe repair

How To Clean

- Use only bleachfree cleaning agents and detergents. (Bleach degrades the Kevlar fiber used in the chaps.)
- Clean by hand:
  - Dirt—let dry and brush off with stiff bristle brush
  - Light oil—brush with warm water and bleachfree detergent solution, and if needed, spray spots with degreaser cleaner (such as Spray n' Wash or Shout) and rinse
  - Heavy oil—spray spots with degreaser cleaner, brush with water and bleachfree detergent solution and rinse
  - Extremely soiled—lay out on flat surface, spray spots with degreaser cleaner, brush with water and bleachfree detergent solution, and rinse thoroughly
- Hang dry.

Remember:

- Do not use detergent or cleaning products that contain bleach
- Do not machine wash or machine dry

How To Repair

- If only the nylon shell is cut or burned through, repair this way:
  - Make a nylon patch of similar material that extends 2 inches (5 cm) beyond the edges of the damage
  - Fold the patch under 1/2 inch (1.3 cm)
  - Handstitch this folded edge to the nylon (Do not sew through the protective pad.)
- If the cut is deeper, into the Kevlar material, repair this way:
  - Use material from previously damaged pair of chaps
  - Make patch equal to the number of layers cut (a patch must contain a layer to match each layer cut)
  - Make a patch that extends 1 inch (2.5 cm)beyond the damaged area
  - Insert the patch under the nylon and sew on all sides and along the cut in the nylon shell (Sewing through the shell decreases protection immediately around the patch.)
- For the details on repair and illustrations of repair techniques, refer to the publication "Inspecting and Repairing Your Chain Saw Chaps," MTDC 8267 2505, December 1982. If you need a copy, contact: Publications, Missoula Technology and Development Center, Ft. Missoula, Building No. 1, Missoula, MT 59801; telephone (commercial and FTS)—406-329-3900; FAX number—406-329-3719; or DG—MTDC:R01A. ■

George Jackson, *equipment specialist, USDA Forest Service, Missoula Technology and Development Center, Missoula, MT*

Firefighters Go West: The Foothills Fire

Roban Johnson

Former information assistant, Chattahoochee-Oconee National Forests, Gainesville, GA

The weekend of August 22, 1992, had barely begun when USDA Forest Service office and field workers got a call to gear up for battle. A battle that would take place hundreds of miles away, high in the rugged terrain of the Boise National Forest, in a fight against the largest wildfire in Idaho history.

For Tom Bardenwerper, weekend gardening plans would have to wait. Instead, he would lead a 20-person fire suppression crew into Idaho's mountainous terrain. Bardenwerper, a Fleet Equipment Manager for the Chattahoochee-Oconee National Forests in Georgia, had been on fires before. But this fire was one of the most difficult he had ever seen. Before it was over, more than 257,000 acres had burned and it had moved northeasterly, threatening nearby Sawtooth National Forest.

Firefighters from the Chattahoochee-Oconee National Forests make their way to the Foothills Fire in the Boise National Forest. Photo credit: Tom Bardenwerper, Chattahoochee-Oconee National Forests.

Fire Chronology

The massive Foothills Fire began on August 19 as five individual lightning-caused fires at the south end of the incident. Initial attack forces from the U.S. Department of the Interior, Bureau of Land Management (BLM) attempted to suppress the fires, but were unsuccessful due to extreme weather conditions and fire behavior. In 4 hours, the five fires had burned together into two fires totalling 15,000 acres.

High winds continued to push the fire to the northeast, and on the second day it spread to approximately 100,000 acres and approached the banks of the south fork of the Boise River. By then, 330 personnel were called in and unified command was soon established between the BLM and the Forest Service.

On the third day the fire was zoned and two Type I teams were ordered. At 1 p.m. the fire began a sustained run crossing the Boise River, advancing to the middle fork. This run consumed 130,000 acres, with total acreage exceeding 200,000. The total number of personnel was now approximately 500.

Cool temperatures and high humidity helped slow the fire's progress on the fourth day. North and South Zones established incident command posts and base camps. Total acreage burned was 232,800. Total number of personnel exceeded 1,000.

Where Did the Crews Come From?

The Forest Service, other Federal and State agencies, and local fire departments participated in fighting the Foothills Fire. Before it was over, 2,887 personnel were assigned to the Foothills Fire. They included personnel from 5 Federal agencies, 17 States, the U.S. Air Force, Idaho National Guard, local counties and cities, and private contractors. The primary resources included 109 hand crews, 13 dozers, 56 engines, 20 helicopters, 3 airtankers, 6 fixed wing aircraft, and 469 overhead personnel.

Eleven crews from the Southeast were brought in to fight the blaze, including the Southern Region Red Team, which served as Incident Command of the North Zone and was in charge of all suppression efforts involving personnel and logistics. The Southern Region Red Team worked out of the Idaho City Ranger District Office under the command of Rex Mann, Kentucky.

Chattahoochee-Oconee Crew Heads West

Bardenwerper saw familiar faces when his crew assembled in Georgia before heading to Idaho. He had worked on fire details with at least 14 of the 20 members, but never with more than 6 of them at the same time. For the most part, Bardenwerper describes each fire as a new experience. With each new fire detail, rapport with other crew members is quickly established. During transport, in camp, and on the fireline, crew members get to know each other pretty well.

Some of the getting acquainted comes from the "hurry up and wait" atmosphere of fire details. Most of Bardenwerper's crew members were notified of the fire before noon on August 22. They wouldn't leave the Supervisor's Office until 6:30 p.m., when they were loaded on a bus, heading for Knoxville, TN. They arrived 4 hours later but were bumped from their flight to Idaho until the next day. The next morning they flew out of Knoxville en route to Idaho, but had to change planes twice—once in Chicago and once in San Francisco. They finally reached Boise, only to be faced with a 60-mile bus ride to Idaho City. Under those conditions, the crew either gets a lot of sleep or learns a lot about their fellow travelers.

The remoteness and the rugged terrain of the Foothills Fire in Idaho meant fire suppression crews had to be airlifted in and out of about 15 different spike camps rather than the usual 2 and had to use coyote tactics.

The crew arrives at a spike camp near heli-spot H22. Photo credit: Tom Bardenwerper, Chattahoochee-Oconee National Forests.

After the crew arrived at base camp, orders were issued. Bardenwerper's crew would be used primarily for mop-up efforts, keeping an eye out for sparks and small fires. This fire, however, was quite different from any other they had worked on because the terrain was rugged and remote, with few, if any, roads for access. They would live in spike camps most of the time, only getting back to base camp every 3 or 4 days.

Coyote Tactics and Spike Camps

Fighting the Foothills Fire requires coyote tactics—a progressive line construction technique involving self-sufficient crews. Crews build fire line until the end of their shift, remain at or near the point while off shift, and begin building fire line again the next shift where they left off previously.

With coyote tactics comes life in a spike camp, where facilities are nonexistent. Beds at Idaho's Foothills Fire were made by digging flat places along the ridges. Crew members had to rely on helicopters to bring food, equipment, and supplies.

"The Foothills Fire was a unique situation," said Leroy Summerour, Property Management Specialist for the Chattahoochee-Oconee National Forests in Georgia. "I've been on fires in Oregon and Northern California, but found this section of Idaho much more rugged."

The remoteness of the Foothills Fire made helicopters the primary transportation sources. Crews are usually airlifted by helicopter only one or two times during a fire detail, but this fire's remoteness and rugged terrain forced Bardenwerper and his

crew to be flown in and out of about 15 different spike camps.

Summerour, who had never flown by helicopter, wasn't sure what to expect. "I don't want to see another helicopter for a while," joked Summerour. "We flew up and down along the mountainous terrain, blown around by the wind. All I could do was put my life in God's hands."

Although Idaho's terrain was much steeper and more rugged than much of the terrain in the East, fighting fires isn't very different. "Eastern crews are not treated any differently than western crews," explains Bardenwerper. "All of us have received excellent fire training and we know what to expect when we get out there."

The crew coordinates firefighting activities with air attacks and other crews on the ground. Photo credit: Tom Bardenwerper, Chattahoochee-Oconee National Forests.

Crew members Gordon Riddoch and Paul Robinson lay a hose line used to mop up the fire. Photo credit: Tom Bardenwerper, Chattahoochee-Oconee National Forests.

The best piece of advice Bardenwerper offers novice firefighter crew members is to have good boots. "The footing out West can be more dangerous than here in the East. Your boots can be the most important piece of personal gear you have with you on fire detail." In addition to good boots, Bardenwerper urges crew members to take with them a good mental attitude. "You've got to be a team member. When you go, you go as a team." He also stresses the mental aspect of waiting and the physical endurance required.

Estimated Losses

The Foothills Fire consumed more than 250,000 acres, including all or parts of 25 grazing allotments, 2 existing commercial timber sales, and commercial timber proposed for sale. Also burned were a big game winter range and two blue ribbon trout streams. One Forest Service facility was destroyed.

Several dozen homes in the area were threatened daily, but only one farm house and three outbuildings were destroyed. Numerous hay fields, hay stacks, and fences were destroyed as well as an unknown number of livestock.

This article was adapted from "SO and District Employees Fight Fires in Idaho," published in *Forest News*, a newsletter of the Chattahoochee-Oconee National Forests, in December 1992.

Roban Johnson is currently a paralegal in Macon, GA. ■

Low-Level Weather Conditions Preceding Major Wildfires

Edward A. Brotak

Professor, Atmospheric Sciences Department, University of North Carolina—Asheville, Asheville, NC

Knowledge of fire behavior is critical for those who control wildfires. Fire managers must know spread rates and intensity—not just to eventually contain and extinguish the fire but also to keep their fire control personnel safe. Managers realize that weather is paramount in importance when determining how a fire will behave. Besides affecting fuel moistures, meteorological factors also physically change fire. Since fires are three-dimensional phenomena, managers need to know how the vertical structure of the lower atmosphere as well as the standard surface conditions affect fire behavior.

Haines (1988) developed a Lower Atmosphere Severity Index (LASI) for wildfires. This index combined two factors that could influence fire behavior: the vertical lapse rate and the amount of moisture in the air. The vertical temperature structure of the lower atmosphere would influence the convection over the fire. Steep lapse rates, indicating instability, would enhance the convection over the fire, thus increasing the chances of extreme or erratic behavior. The amount of moisture in the lower atmosphere is a factor that influences fuel moisture at the surface. Low humidity values contribute to extreme fire behavior.

Since the fires in Haines' study occurred at various elevations, he used different pressure levels to indicate the low-level lapse rates. Depending on the actual elevation of the fire, he used either the 950 to 850 mb temperature difference, the 850 to 700 mb difference, or the 700 to 500 mb difference. As indicators of moisture content, he used either the 850 or 700 mb temperature and dewpoint difference. The actual LASI that Haines developed is shown in the following equation:

A goal of this study was to see if the instability and dryness of the lower atmosphere, common during the occurrence of extreme fire behavior, is discernable 12 hours earlier.

$$\mathrm{LASI} = a(T_{p1} - T_{p2}) + b(T_p - T_{dp}),$$

where T is the temperature at two pressure surfaces (p1, p2), T_p and T_{dp} are the temperature and dewpoint at one of the levels (all temperatures in °C and a and b are weighting coefficients given equal value for this study).

Haines calculated LASI values for 74 fires using radiosonde measurements at 0000 Greenwich Mean Time (GMT). In North America, these are late afternoon or early evening soundings and should usually represent actual conditions when the extreme fire behavior was noted. A vast majority of the fires occurred on days with steep lapse rates and low humidities. Comparisons with the Standard Atmosphere and with a simple climatological data set computed for this study showed that these extreme fire conditions were indeed abnormal. Approximately 5 percent of all fire season days fell into the high-index category of the LASI, but 45 percent of days with large fires or erratic behavior were in this category.

The current study differs from Haines' work in two ways. First, 1200 GMT data were analyzed. These are the morning soundings and would represent typical data available to fire weather forecasters who are trying to predict fire conditions later in the day. As previously mentioned, the LASI was developed using 0000 GMT data when extreme fire behavior was actually occurring. A goal of this study was to see if the instability and dryness of the lower atmosphere, common during the occurrence of extreme fire behavior, is discernible 12 hours earlier. The second difference from Haines' study is the analysis of the vertical wind profile.

The effects of the change in wind speed with height on wildfire behavior have been discussed in several previous studies. Byram (1954) stressed the importance of a low-level jet—stronger winds at low levels with decreasing winds aloft. An interpretation of Byram's work indicates that he was not as much concerned about an actual low-level wind maximum as he was about minimal amounts of vertical wind shear. It has been long realized that a lack of vertical wind shear allows convection to develop. Such a wind profile over a wildfire would allow the convective column above the fire to develop more fully. This would increase the fire's intensity and its potential for extreme behavior.

Brotak and Reifsnyder (1977) analyzed 60 fires in the Eastern United States. They found that strong winds throughout the vertical profile were common and in most cases wind speeds increased with height. Although a third of the wind profiles in their study showed low-level jets, even in these cases, wind speeds were much stronger than the Byram model would allow for. It was their conclusion that fires in the Eastern United States, which were mostly at low elevations, were primarily driven by

strong winds and that convection above the fire was usually not as important. The current study examines fires at various elevations and in various terrains to see if any correlations exist with the vertical wind profile.

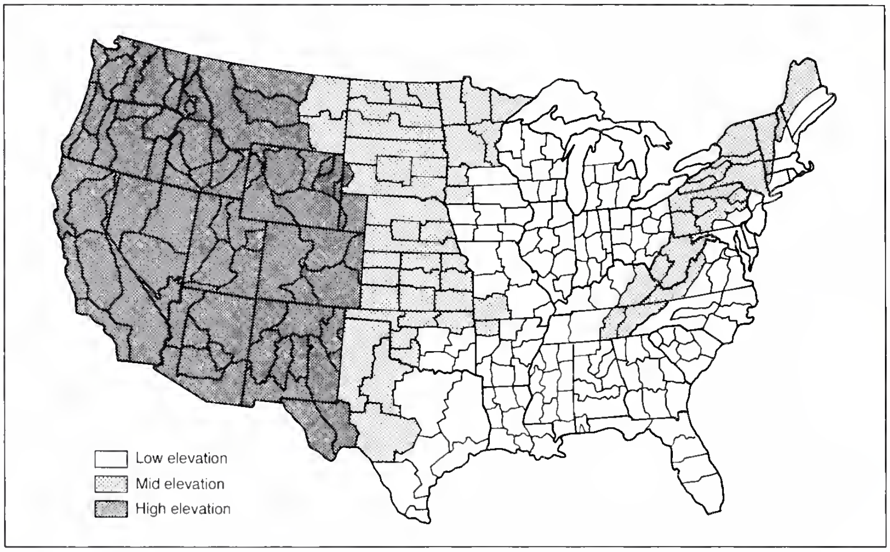
Data

The fires examined were the same used in Haines' study. These consisted of 29 major fires in the West and 45 fires in the East. Soundings from one to three nearby radiosonde sites were analyzed to determine both the vertical temperature and wind profiles. The 1200 GMT data were used, which represented conditions in the morning prior to the extreme fire behavior.

To allow for the varying elevations, the country was divided into three broad regions as shown in figure 1. For much of the eastern part of the country, the 950 to 850 mb temperature difference, the 850 mb dewpoint depression, and the surface to 700 mb wind profile were examined. For the Appalachian Mountains and much of the Great Plains, the 850 to 700 mb temperature difference, the 850 mb dewpoint depression, and the surface to 600 mb wind profile were used. For the high elevations of the Western United States, the 700 to 500 mb temperature difference, the 700 mb dewpoint depression, and the surface to 500 mb wind profile were analyzed.

The lapse rate component was broken down into three categories for each level. For a reference point, the Standard Atmosphere (NOAA et al. 1976) lapse rate was used. The standard value for the 950 to 850 mb temperature difference is ~6 °C, for

Figure 1—*Map of the United States climatic divisions showing regional elevation aspects of the LASI.*



850 to 700 mb it is ~10 °C, and for 700 to 500 mb it is ~17 °C. The LASI was computed using the following:

LASI = A + B

A = 1 if 950-850 T < 4 for low-elevation fires or 850-700 T < 6 for mid-elevation fires or 700-500 T < 18 for high-elevation fires.

A = 2 if 950-850 T = 4 to 8 for low-elevation fires or 850-700 T = 6 to 11 for mid-elevation fires or 700-500 T = 18 to 22 for high-elevation fires.

A = 3 if 950-850 T > 8 for low-elevation fires or 850-700 T > 11 for mid-elevation fires or 700-500 T > 22 for high-elevation fires.

B = 1 if 850 ($T - T_d$) < 6 for low- and mid-elevation fires or 700 ($T - T_d$) < 15 for high-elevation fires.

B = 2 if 850 ($T - T_d$) = 6 to 10 for low-elevation fires or 6 to 13 for mid-elevation fires or 700 ($T - T_d$) = 15 to 21 for high-elevation fires.

B = 3 if 850 ($T - T_d$) > 8 for low-elevation fires or 11 for mid-elevation fires or 700 ($T - T_d$) > 21 for high-elevation fires.

Analysis

Table 1 shows the breakdown of the fires into the various lapse rate, humidity, and LASI categories. The humidity component of the LASI, either the 850 or 700 mb dewpoint depression, was comparably low for both the 1200 GMT data used in this study and the 0000 GMT data used by Haines. Therefore, dry conditions in the lower atmosphere certainly seem to be a necessary factor prior to the occurrence of extreme fire behavior. The analysis of low-level lapse rates

Table 1—*Percentage of occurrence of fires by LASI variants for 1200 GMT soundings with 0000 GMT data in parentheses () for comparison*

	Low-Elevation Fires (21 Fires)	
Lapse rate 950 - 850 mb T	Humidity 850 (T - T_d)	LASI
< 4: 24% (4%)	< 6: 10% (9%)	2 - 3: 14% (2%)
4 - 8: 62% (13%)	6 - 10: 19% (22%)	4: 24% (13%)
> 8: 14% (83%)	> 10: 71% (69%)	5: 57% (34%)
		6: 5% (51%)
	Mid-Elevation Fires (28 Fires)	
850 - 700 mb T	850 (T - T_d)	LASI
< 6: 7% (7%)	< 6: 0% (9%)	2 - 3: 4% (6%)
6 - 11: 57% (35%)	6 - 13: 32% (31%)	4: 25% (16%)
> 11: 36% (58%)	> 13: 68% (60%)	5: 43% (45%)
		6: 28% (33%)
	High-Elevation Fires (25 Fires)	
700 - 500 mb T	700 (T - T_d)	LASI
< 18: 12% (13%)	< 15: 4% (7%)	2 - 3: 4% (10%)
18 - 22: 48% (34%)	15 - 21: 24% (17%)	4: 24% (21%)
> 22: 40% (53%)	> 21: 72% (76%)	5: 44% (24%)
		6: 28% (45%)

did show differences between the two data sets; the 1200 GMT soundings used in this study indicated less instability.

Only 14 percent of the low-elevation soundings were decidedly unstable at 1200 GMT as compared to 83 percent at 0000 GMT. The mid-elevation soundings were only slightly more unstable with 36 percent falling into the least stable category in this study in comparison to 58 percent in the Haines' analysis. The high-elevation soundings showed the least difference between 1200 and 0000 GMT. In both studies, nearly 90 percent of the soundings showed lapse rates greater than the Standard Atmosphere rate.

Low-level lapse rates are significantly affected by the radiation budget of the underlying surface. At night, the surface loses heat, and the lower atmosphere is cooled from below. This produces stable lapse rates at low levels. During the day, the surface gains energy from solar radiation, and the lower atmosphere is heated from below. This produces steep lapse rates and unstable conditions. The result of these processes is a major change in low-level lapse rates from 1200 to 0000 GMT with the 1200 GMT sounding not being particularly representative of conditions later in the day.

The computational problems caused by radiational cooling at night could be dealt with if these effects were concentrated within a nocturnal inversion layer. Lapse rate calculations could be adjusted for some level above the top of the inversion. The soundings were examined specifically for the occurrence of nocturnal inversions. The lowest levels used to calculate lapse rates were almost always above the nocturnal inversion. Only in three cases did the nocturnal inversion reach the 950 mb level for low-elevation soundings. Although nocturnal inversions were not a problem, other types of inversions were more prevalent. Fourteen of the soundings did display low-level inversions which affected the lapse rate calculations. Strong surface heating during the day could have easily destroyed many of these inversions leading to more unstable conditions by 0000 GMT. As a result of this, the calculated LASI values were lower and were not good predictors of extreme fire behavior. As previously mentioned, only the high-elevation soundings showed consistency from 1200 to 0000 GMT. This is due to the location of the radiosonde station. Often the radiosonde station is at a much lower elevation than the fire site. The 700 mb temperature, which is considered a near surface temperature for the fire site, is a "free air" reading at the radiosonde location and is not as affected by radiational effects of the surface as lower temperatures like the 850 mb would be.

The analysis of the 12 GMT low-level wind profiles is shown in table 2. There are definite regional differences in these data. Nearly three-fourths of the high-elevation fires in the West occurred with light surface winds and little vertical wind shear. Again, it must be pointed out that the radiosonde sites may not truly represent conditions at the fire location. Certainly, topographic

and other local effects could produce stronger surface winds in the mountains.

The lack of strong winds aloft is probably a function of the time of year. As shown in table 3, most of the western fires (high-elevation fires) occurred in the summer when overall pressure patterns are weak. The worst conditions in terms of low fuel moistures also usually occur under an upper-level ridge that favors weak synoptic-scale winds. Fires in the West seem to follow Byram's model where convection over the fire is an important factor. Almost all of the mid-elevation fires occurred when the surface winds were moderate to strong and with substantial vertical wind shear. Low-level jets were noted on 33 percent of the soundings. These fires seemed to fit into Brotak and Reifsnyder's model of wind-driven fires. The majority of these fires occurred in the spring and fall (table 3) when weather systems are stronger. Surprisingly, the low-elevation eastern fires showed no distinctive pattern in the wind analysis. It should be remembered that surface winds usually increase from 1200 to 0000 GMT due to the turbulent mixing during the day.

Table 2—*Number and percentage of fire occurrence by low-level wind profile in knots (m/sec)*

	Light	Moderate	Strong
Low-elevation fires	12 (6) (48%)	7 (4) (24%)	6 (4) (28%)
Mid-elevation fires	1 (1) (4%)	11 (6) (46%)	12 (6) (50%)
High-elevation fires	13 (7) (72%)	4 (2) (16%)	3 (2) (12%)

Light: surface winds < or = 5 knots (3 m/sec); upper winds < or = 25 knots (13 m/sec)
Moderate: surface winds 5 to 9 knots (3 to 5 m/sec) and/or upper winds 26 to 34 knots (13 to 18 m/sec)
Strong: surface winds > 9 knots (5 m/sec) and/or upper winds > 34 knots (18 m/sec)

Table 3—*Fires by elevation and month*

	Jan	Feb	Mar	Ap	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Low-elevation	1		6	9	2	1		2	1			
Mid-elevation				12	2		5		4	1		
High-elevation					1	8	4	9	5		1	

Summary and Recommendations

Haines' LASI for classifying atmospheric conditions during periods of extreme fire behavior using 0000 GMT soundings was not as useful in predicting these conditions as when 1200 GMT data are used. The destabilization of lapse rates due to solar heating during the day seems to be the main problem. One possible solution would be to use a predicted afternoon surface temperature to do the calculations with the 1200 GMT soundings. Another possibility is to compare the 1200 GMT values with climatology. This study could only use as reference points the Standard Atmosphere lapse rate and the 0000 GMT results from Haines' study. For the most accurate comparisons, long-term averages for each radiosonde station need to be developed.

The analysis of low-level wind profiles also produced mixed results. In many circumstances, strong surface winds in conjunction with low fuel moistures cause fire-control problems. Climatologically, these conditions are more prevalent in the East. In the West, where the lowest fuel moistures often occur in the summer, strong winds on the synoptic scale are rare. These fires seem to be controlled more by local or topographically induced winds and by convection over the fire.

Acknowledgments

This research was funded by Cooperative Agreement Number 23-88-33 of the USDA Forest Service. ■

Literature Cited

Brotak, E.A.; Reifsnyder, W.E. 1977. Predicting major wildland fire occurrence.Fire Management Notes. 38(3):5-8.

Byram, G.M. 1954. Atmospheric conditions related to blowup fires. USDA Forest Service Sta. Pap. 35. 31 p. (Available from USDA Forest Service, Southeastern Forest Experiment Station, Rt. 1, Box 182-A, Dry Branch, GA 31020.)

Haines, D.A. 1988. A lower atmospheric severity index for wildland fires. National Weather Digest. 13(2):23-27.

National Oceanic and Atmospheric Administration; National Aeronautics and Space Administration; U.S. Air Force. 1976. U.S. Standard Atmosphere. Washington, DC. 227 p.

1992 Silver and Bronze Smokey Bear Awards Announced

The Cooperative Forest Fire Prevention (CFFP) Program Executive Committee has chosen seven recipients to receive the 1992 silver and bronze Smokey Bear statuettes for their exceptional forest fire prevention efforts. These awards were presented by a Regional or State Forester (or representative) at special ceremonies.

Silver Awards. These statuettes are presented to persons or organizations that have made outstanding regional or multistate contributions in forest fire prevention over a 2-year period. The recipients included:

The Utah Jazz Basketball team, Salt Lake City, UT, for its prevention program in the Intermountain West. The Jazz have provided Smokey Bear with numerous platforms to address the widely disparate populations in the Great Basin.

Gordon Eugene (Gene) Dowdy, special prevention activities program manager, for his "grassroots" involvement with wildland fire prevention agencies in California. Dowdy's work evolved into the nationwide program "Smokey and the American Cowboy."

Bronze Awards. These statuettes are given to individuals or organizations that have provided outstanding statewide service in wildfire prevention for at least 2 years. Recipients were:

Pat Kidder, California State fire management officer for the Bureau of Land Management, for his 15 years of enthusiastic and effective efforts in interagency fire prevention programs, including Special Prevention Activities and the National Wildfire Coordinating Group Fire Prevention Working Team.

William R. Baker, program director for the Manitoba Forestry Association, for his 12 years of dedication to the Smokey Bear program. He reaches 15,000 schoolchildren with Smokey's fire prevention message annually.

Susan Benson, community affairs director for WGME-TV in Portland, ME, for developing and producing five effective television public service announcements (PSA's) about forest fire prevention. These PSA's have been used all over the State.

The Kroger Co. of Louisville, KY, for working with the Kentucky Division of Forestry to promote wildfire prevention by including prevention messages on their grocery bags. For each of the past 2 years, 19 million bags were printed and distributed to the 61 grocery stores in Kentucky and 1 million were printed and distributed in Virginia.

Richard A. Henry (left), director, Fire and Aviation Management, Pacific Southwest Region, USDA Forest Service presented a Silver Smokey Bear Award to Gene Dowdey (right), special prevention activities program manager, USDA Forest Service. Photo credit: Nancy Porter, USDA Forest Service, Pacific Southwest Region.

The Golden Eagles Hockey Club of Salt Lake City, UT, for its involvement with children and young adults through PSA's, space on arena score boards, a video, and graphics. It also produced wildfire prevention items to distribute to fans.

Future Awards Available. It is possible to award 3 golden, 5 silver, and 10 bronze awards each year. Since 1957, 46 golden, 56 silver, and 208 bronze awards were presented through the USDA Forest Service. Nominations for the 1993 awards were due October 15, 1993. Start thinking now about your nominations for 1994 as we celebrate Smokey Bear's 50th year of preventing carelessly caused wildfires. Make your nominations through your USDA Forest Service Regional Forester. ■

Representative's of Utah Jazz received a Silver Smokey Bear Award from USDA Forest Service officials. Utah State, USDI, Bureau of Land Management officials, and Smokey Bear also were on hand. Photo Credit: Fran Cragle, State of Utah.

Mary Ellen Holly, *fire prevention officer, USDA Forest Service, Willamette National Forest, Rigdon Ranger District, Oakridge, OR, recently served as program specialist for USDA Forest Service's Cooperative Forest Fire Prevention Program in Washington, DC.*

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